

An aerial photograph of the Clyde Dam construction site. The dam is a large concrete structure with a central powerhouse. The river flows through the dam, and the surrounding area is a mix of natural terrain and construction activity. The text "CLYDE DAM" is overlaid in the top left, and "CLUTHA POWER" is overlaid in the bottom left in large yellow letters.

CLYDE DAM

CLUTHA POWER

CLYDE

New Zealand's

The largest concrete gravity dam in New Zealand is being constructed at Clyde.

There will be a million cubic metres of concrete in the dam with another 200,000 cubic metres in the powerhouse.

The Clyde power station will initially be capable of producing 432 megawatts of power from four turbine-generator units. This will produce an average 1938 gigawatts of power a year which is enough to keep the cities of Christchurch and Dunedin supplied with power.

There is provision to add two more turbine-generators to the Clyde powerhouse which would increase the capacity to 610 megawatts.

Construction of the Clyde power station is being undertaken for Electricorp, New Zealand's largest electricity generation and marketing company.

The Ministry of Works and Development is responsible for the design and construction of the civil works. MWD forces are constructing the powerhouse with installation of generating equipment being undertaken by Electricorp.

A contracting joint venture involving Ed Zublin from Dusseldorf in West Germany and Williamson Construction from Christchurch, New Zealand, is responsible for placing about 850,000 cubic metres of con-

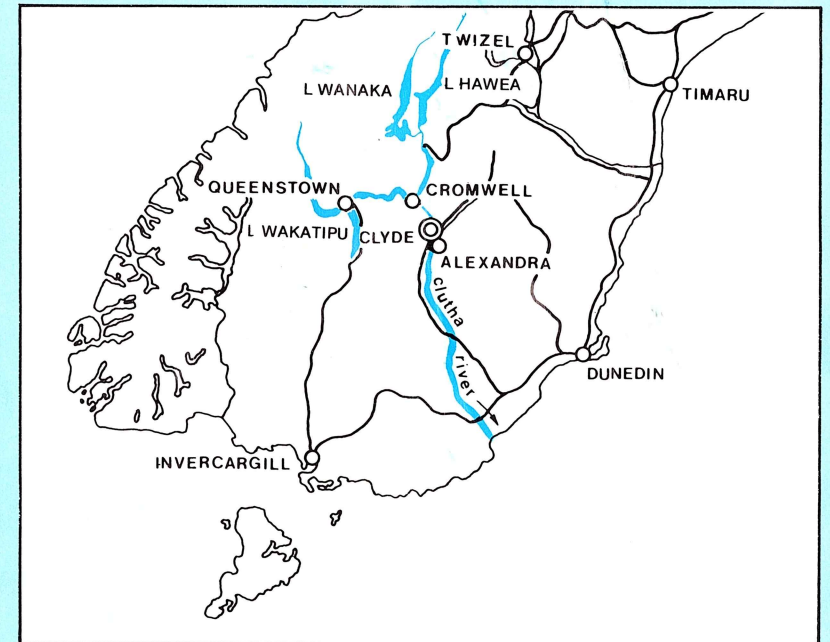
crete in the dam and spillway and erecting the penstocks.

Initial site work at Clyde including diversion of the river in 1982 and construction of the right abutment of the dam was carried out by the MWD.

During the peak of construction in 1986 and 1987 a thousand workers were employed directly on the Clyde site. An additional 200 men and women were employed in the industrial area of Cromwell, the Cromwell project office and on road construction. During the period of peak employment at least half a million dollars a week in wages were paid.

The concrete for the Clyde dam is batched on site using aggregates from the nearby Earnsclough gold tailings. Cement is brought to the site from Burnside near Dunedin and Tarakohe in Golden Bay, Nelson.

Central Otago experiences extremes of temperature ranging from more than 30 degrees centigrade in summer to -10 deg C in winter. Consequently measures have to be taken to control the temperature during the batching of concrete. Two differing techniques are used on the project to reduce the batch temperature during the heat of summer. In one concrete plant flaked ice is mixed with the batching water while liquid nitrogen is injected into the mix in the other plant. The mix water has to be heated during the winter.



The dam will be 490 metres across the crest and rise 60 metres above the existing river level. It is more than 100 metres from the crest to the deepest foundations.

Behind the dam will be a 26 square kilometre storage lake which will be called Lake Dunstan. The lake will stretch 20 kilometres up the Cromwell Gorge to Cromwell township then spread out over the Lowburn Flats.

The lake will inundate the old commercial area of Cromwell. This led to the development of the new Cromwell mall which was officially opened in February 1985.

The lake will take about three months to fill and have an operating range of one metre.



CLYDE DAM

The Clyde Power Project is being constructed for the Electricity Corporation of New Zealand by the Ministry of Works and Development.



\$1-

largest concrete dam

Many options considered

The Clutha and Kawarau Rivers were first seriously considered as major sources of hydro electric power in the early 1940s.

In 1944 both rivers were surveyed and a decision was made to build a dam at Roxburgh. This 320 megawatt station was commissioned in 1956 with the last turbine being brought into operation in 1963.

Attention then turned to further hydro-electric potential in the area.

In the 1970s the Clutha Valley Development schemes were proposed. A number of developments were considered with much political debate about the two most favoured options, Schemes F and H. Both schemes proposed two developments on the Kawarau with hydro-electric power schemes at Luggate and Queensberry. The difference between the schemes was in the Cromwell Gorge where Scheme F proposed one high dam at Clyde. Scheme H proposed two lower dams in the gorge.

The effects of both on and upstream of Cromwell would have been the same. Scheme H with the low dams would have had less impact on the orchards in the Cromwell Gorge.

In 1976 the Government of the day decided to proceed with Scheme F because it was considered this pro-

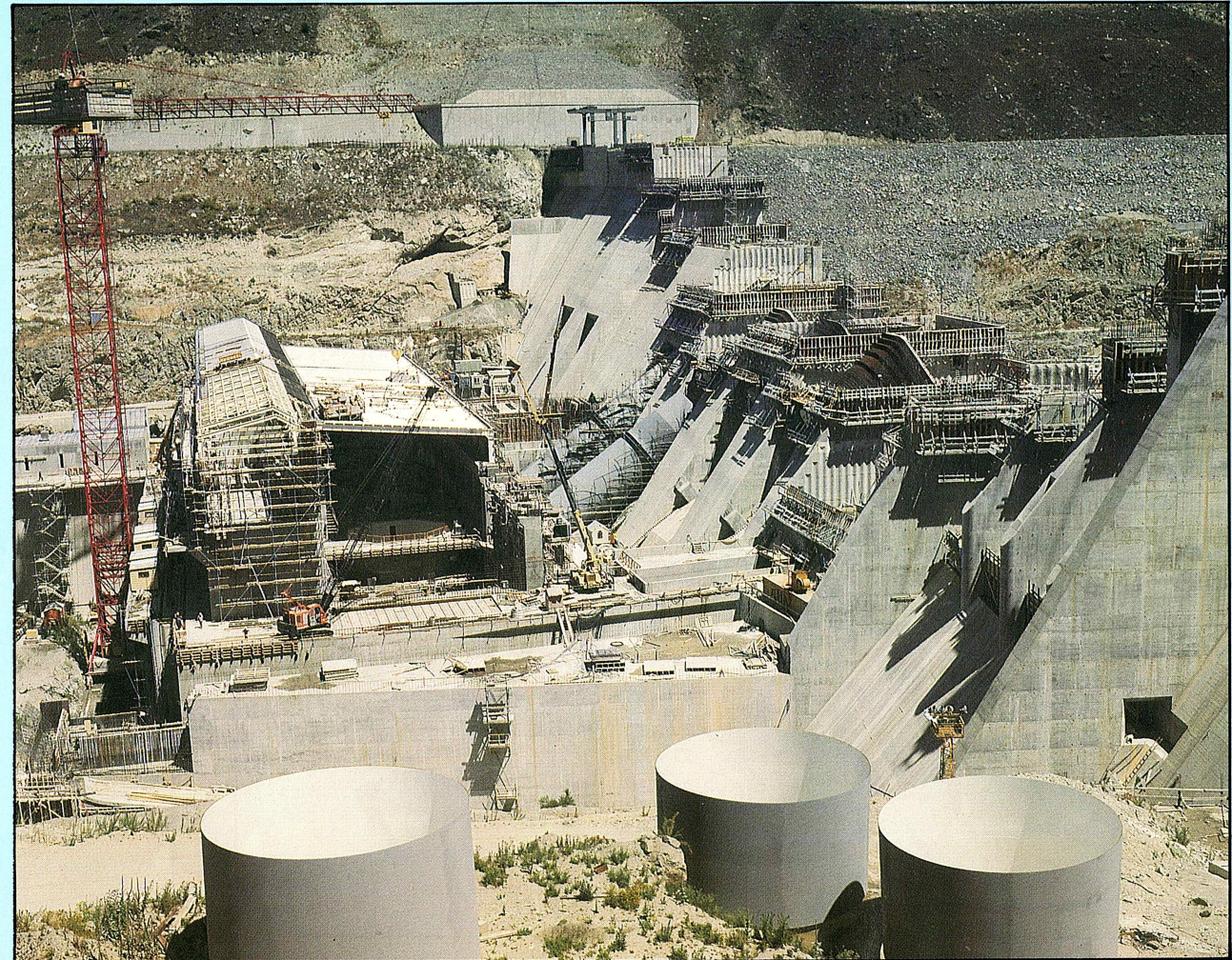
vided a greater power potential at a lower construction cost per unit of electricity.

Since then, there have been a number of changes to the timing and scope of the adopted scheme. Private developers had proposed building an aluminium smelter at Aramoana near Dunedin. The smelter would have been an extremely large user of electricity and the abandonment of the proposed development in 1982 led to the re-scheduling of Clyde, Luggate and Queensberry.

In 1985 the Kawarau investigation phase of the development was discontinued as a result of the Government's announcement the river would be protected for environmental reasons.

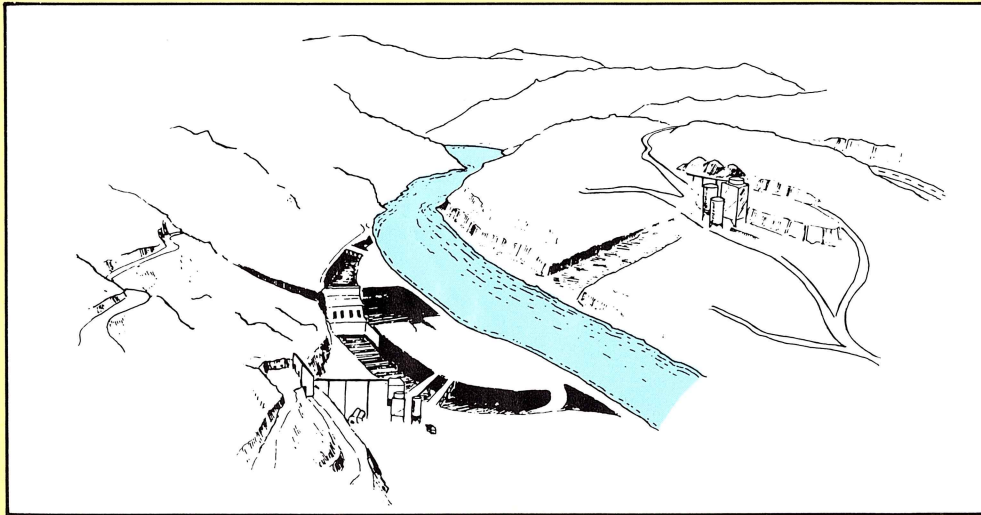
In 1987 the Luggate and Queensberry developments were deferred as a result of a commercial decision by the newly-formed Electricity Corporation. This led to the winding down of the Clutha Valley Development workforce.

In addition to the Luggate and Queensberry dam sites, investigations have been carried out into proposed hydro projects in the Lower Clutha area downstream of the Roxburgh Dam.

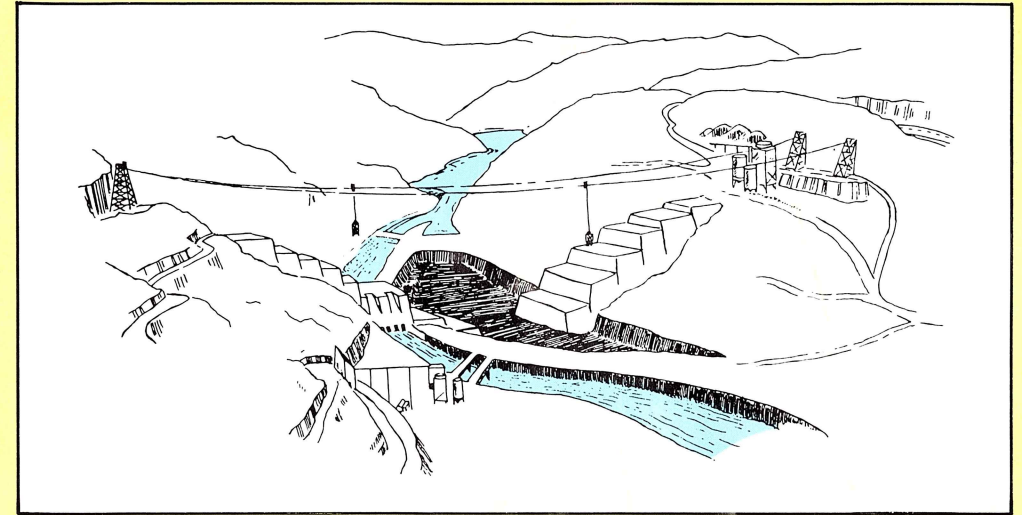


The Clyde Dam and Powerhouse. Penstock sections are in the foreground.

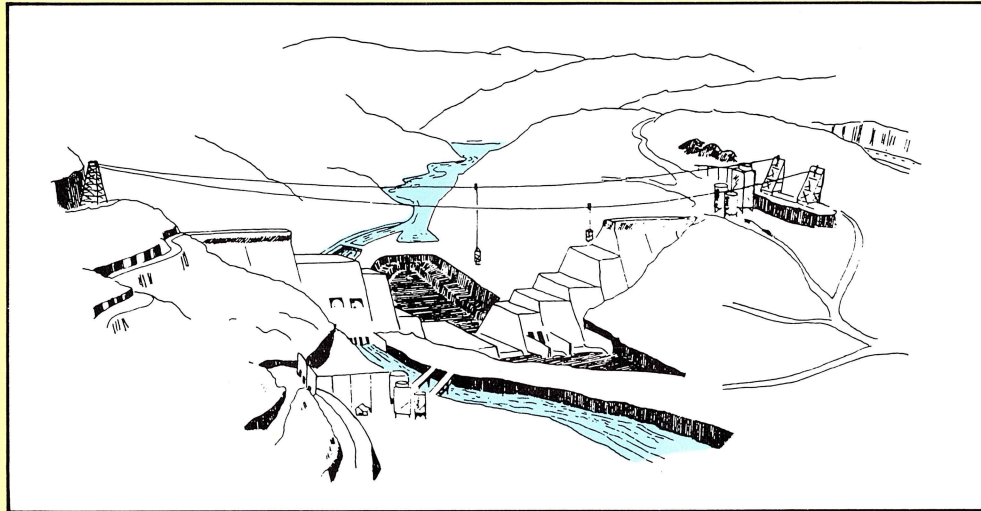
MAJOR CONSTRUCTION STAGES . . .



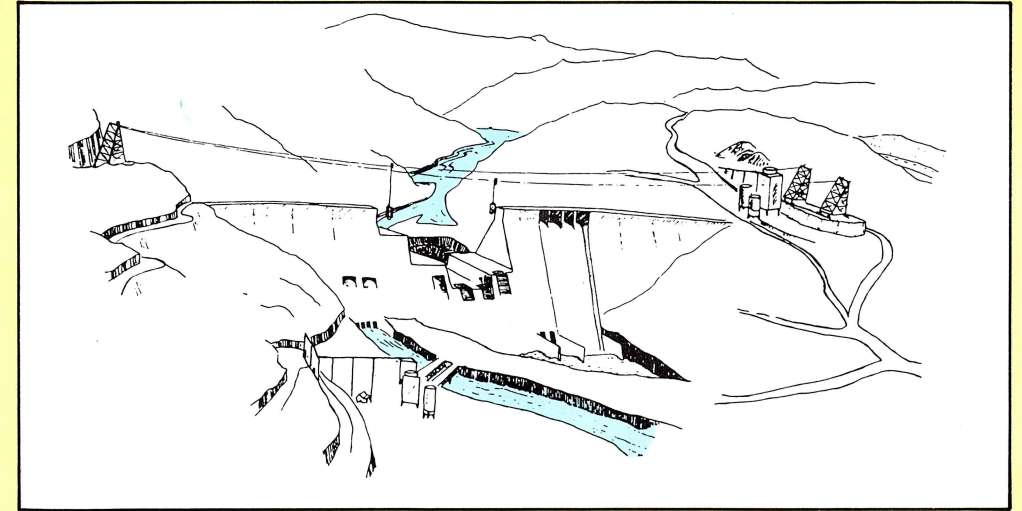
1 Diversion channel excavated — to a depth up to 22 metres, a width of up to 50 metres and a length of 700 metres. Diversion sluices built, dam abutments partially excavated. Left bank batching plant and aggregate bins under construction.



2 Temporary coffer dams in place and river diverted. Left bank batching plant and aggregate bins complete. Cable crane erected and operational. Dam construction under way. The powerhouse would be partly built at this stage, but has been omitted for clarity in this and subsequent sketches.



3 Right abutment of the dam complete. Penstocks installed in diversion blocks. Spillway blocks and stilling basin being constructed.



4 The dam nearing completion. Spillway and stilling basin finished.

CLYDE DAM

Statistics

Construction start: 1977

River diversion: 1982

First power capable: 1989

Initial generating capacity: 432 megawatts

Total concrete: 1.2 million cubic metres

Crest length: 490 metres

Dam height: 60 metres

Lake size: 26.4 square kilometres

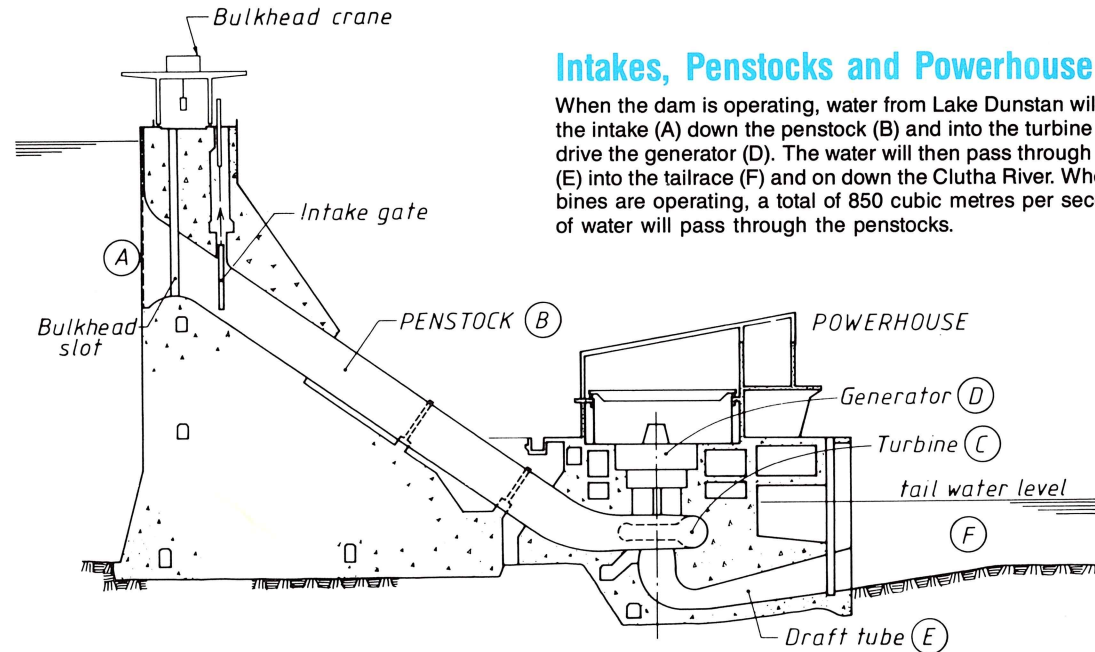
**Final estimated cost
as at September 1987: \$955 million**

This figure is made up of Ministry of Works and Development civil works for Clyde: \$591 million. Electricorp Works, Clyde: \$175 million. Roading: \$100 million. Property compensation: \$24 million. Cromwell Township: \$65 million.

Generating plant: Four Hitachi vertical Francis turbines each driving 108MW, 125rpm, 15.4kV salient pole Hitachi generators. Each generator is connected by air insulated isolated phase busbars to Tyree step up transformers connected to Brown Boveri SF6 gas insulated switchgear. The switchgear is housed in a covered gallery within the powerhouse structure. Transmission is connected via the existing 220kV Roxburgh/Twizel overhead lines.

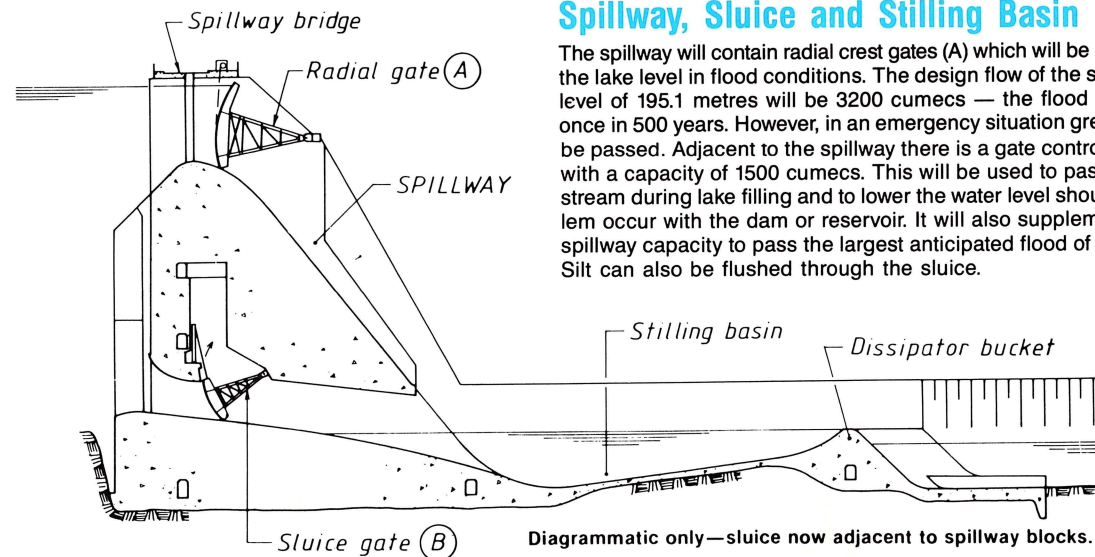
The dam design incorporates a "slip joint" to accommodate any earthquake movement. Geologists consider there is a low to very low possibility of movement along the Dunstan Fault upstream of the dam in the event of a major earthquake. Such a movement could lead to up to 200mm of relative movement on the river channel fault at the dam site. The "slip joint" could accommodate up to two metres of movement.

CROSS SECTION DRAWINGS OF CLYDE DAM



Intakes, Penstocks and Powerhouse

When the dam is operating, water from Lake Dunstan will flow through the intake (A) down the penstock (B) and into the turbine (C) which will drive the generator (D). The water will then pass through the draft tube (E) into the tailrace (F) and on down the Clutha River. When all four turbines are operating, a total of 850 cubic metres per second (cumecs) of water will pass through the penstocks.



Spillway, Sluice and Stilling Basin

The spillway will contain radial crest gates (A) which will be used to control the lake level in flood conditions. The design flow of the spillway at lake level of 195.1 metres will be 3200 cumecs — the flood flow expected once in 500 years. However, in an emergency situation greater flows can be passed. Adjacent to the spillway there is a gate controlled sluice (B) with a capacity of 1500 cumecs. This will be used to pass water downstream during lake filling and to lower the water level should some problem occur with the dam or reservoir. It will also supplement the dam's spillway capacity to pass the largest anticipated flood of 6820 cumecs. Silt can also be flushed through the sluice.

Diagrammatic only—sluice now adjacent to spillway blocks.

Roading posed many challenges

One of the more memorable aspects of the Clyde power project for travellers through the area and those who live in Central Otago has been road blocks.

Lake Dunstan floods the site of the old highway and rail line which followed the floor of the valley between Clyde and Cromwell. A new highway has been constructed along the hillside above the new lake shore.

Road blocks were necessary to enable the contractors to work without endangering motorists with falling rock.

At first there were 20 minute stoppages followed by hour-long blocks with traffic being cleared on the hour.

The Clyde power project roading construction took 10 years and involved 50 kilometres of roading and several bridges and culverts. Twenty major contracts were involved and at least 20 million cubic metres of rock and gravel moved.

The bridge construction included the \$2.4 million Deadmans Point Bridge at the entrance to Cromwell, the bridge over the Lowburn Inlet and the \$1.4 million Bannockburn Bridge.

The most challenging road work was in the Cromwell Gorge where problems of unstable slide areas had to be overcome.

The Cromwell/Wanaka highway was realigned for four kilometres on

either side of Lowburn. Thirteen kilometres of State Highway 8 between Cromwell and Tarras were also realigned.

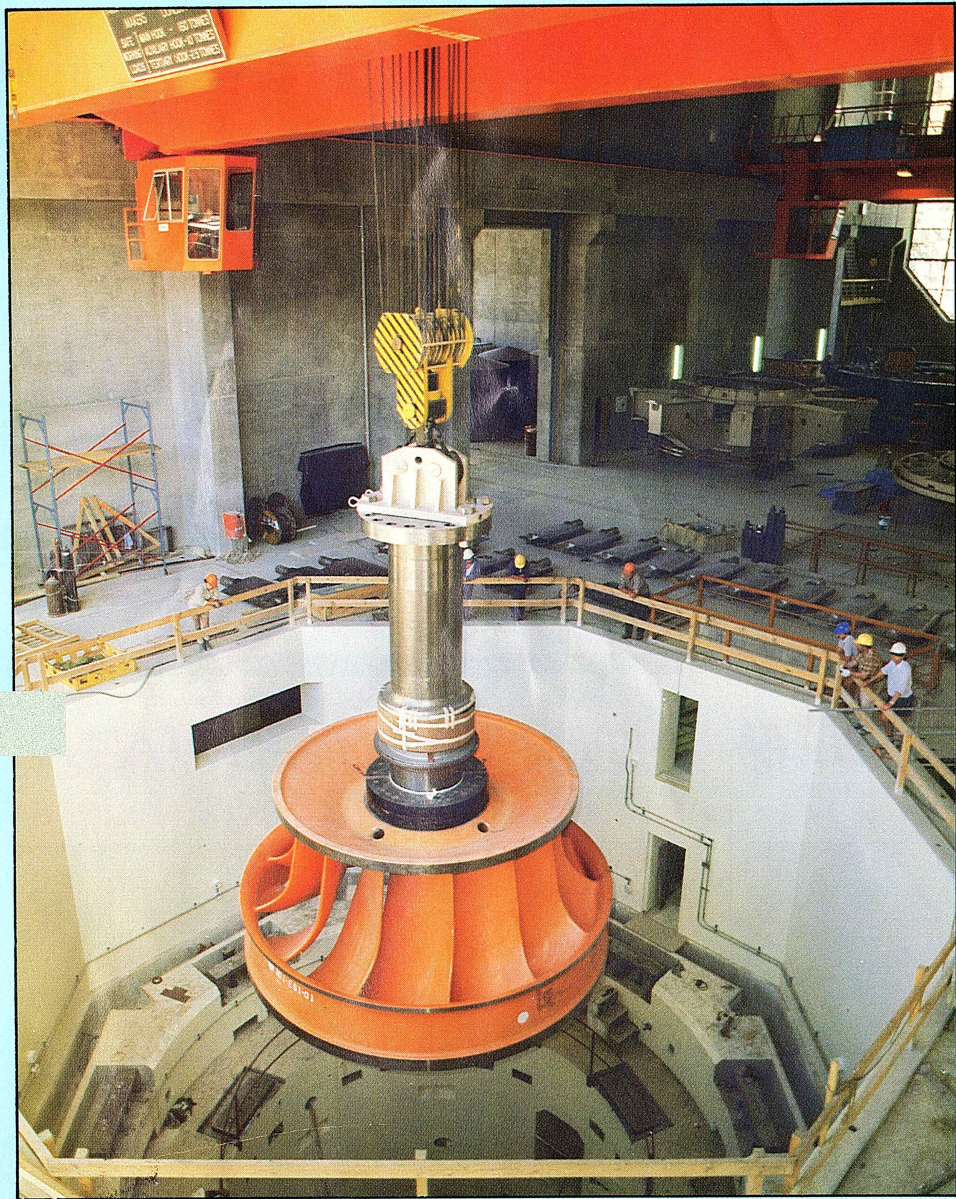
The new highways will follow along the side of Lake Dunstan and will provide vastly different scenes from those viewed from the old roads, particularly the road through the Cromwell Gorge.

Travellers heading from Clyde to Cromwell will now be able to view arid tussock slopes and rock bluffs meeting the blue of the lake. Rounding the corner towards Cromwell will reveal a panoramic view of a lakeside town. The three churches and two Wellingtonian trees will be prominent near the lake edge and the present meeting of the rivers will be replaced by a merging of the two arms of Lake Dunstan.

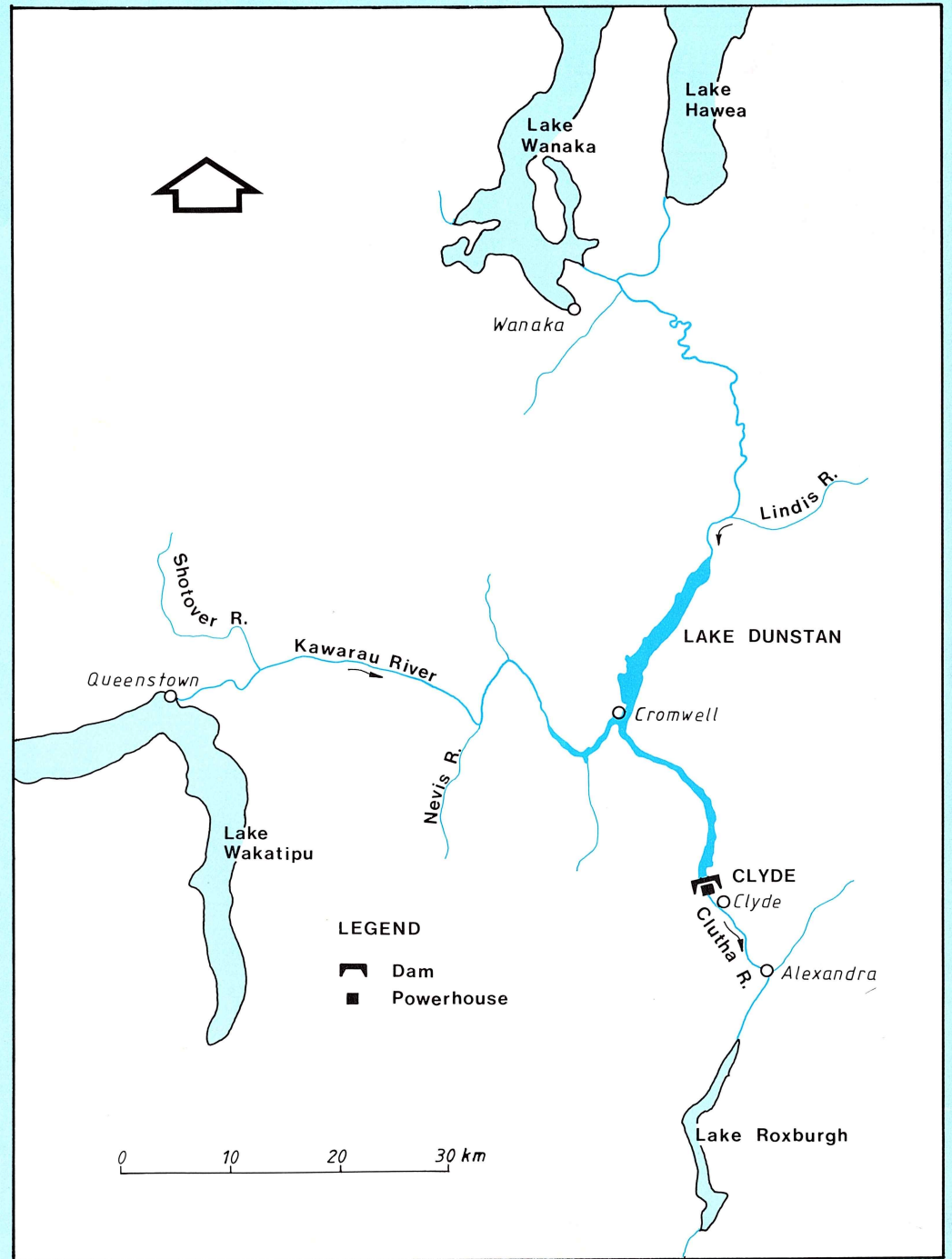
ABOVE: The \$2.4 million Deadmans Point Bridge at the entrance to Cromwell. It is a standard steel truss bridge with a concrete deck and is 272 metres long.

BELOW: Constructing a new highway through the Cromwell Gorge posed many challenges. The last section of road was opened in early 1988.





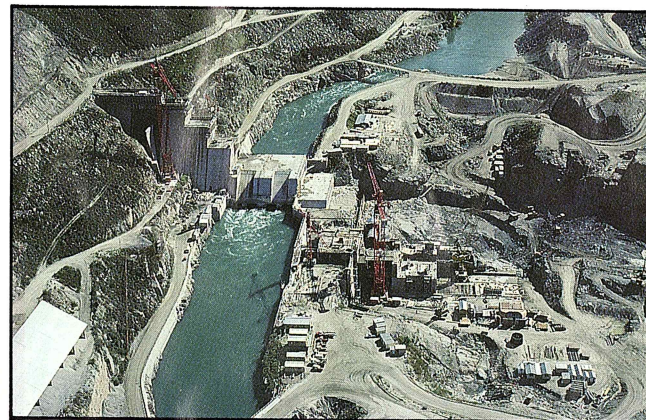
ABOVE: A turbine is lowered into one of the four machine bays in the Clyde powerhouse.



PROGRESS CALENDAR



1982



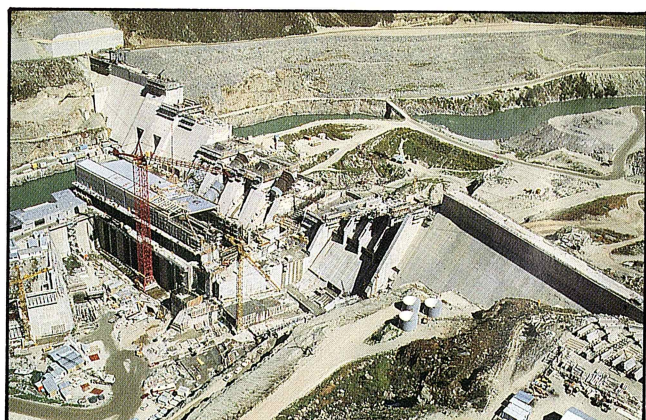
1984



1985



1986



1987

Development leads to many changes

The development of the Clyde power project has led to many changes in Central Otago.

The full effects of the proposed development were comprehensively covered in the Environmental Impact Report and Audit on the Clutha Valley Development, prepared as a requirement of the Environmental Protection and Enhancement Procedures which were introduced by the Government in 1974. The report and audit are available from most major libraries.

The major environmental impact is the formation and filling of Lake Dunstan behind the Clyde dam. This 26.4 square kilometre lake has led to the loss of 12 orchards in the Cromwell Gorge, the old commercial area of Cromwell and the Lowburn Flats.

In some cases this has led to major disruption to orchards and businesses which have been in families for generations.

Many locals and visitors have felt a sense of loss to see fruit trees and old buildings demolished and the beauty of the meeting of the rivers will not be easily replaced.

Lake Dunstan will flood 1405 hectares of productive land, 605 of which was classified as good land (Classes 1 to 111). A total of 86 hectares of orchards, most of which produced early apricots have been lost.

Compensation for those affected has taken many forms.

Most of those in business in the old commercial area of Cromwell were relocated to the new Cromwell Mall. Some of the old buildings have also been relocated to an historic precinct by a group called Old Cromwell Inc.

Several new orchards have been developed near Cromwell, concentrating on the exporting of nectarines, cherries and peaches.

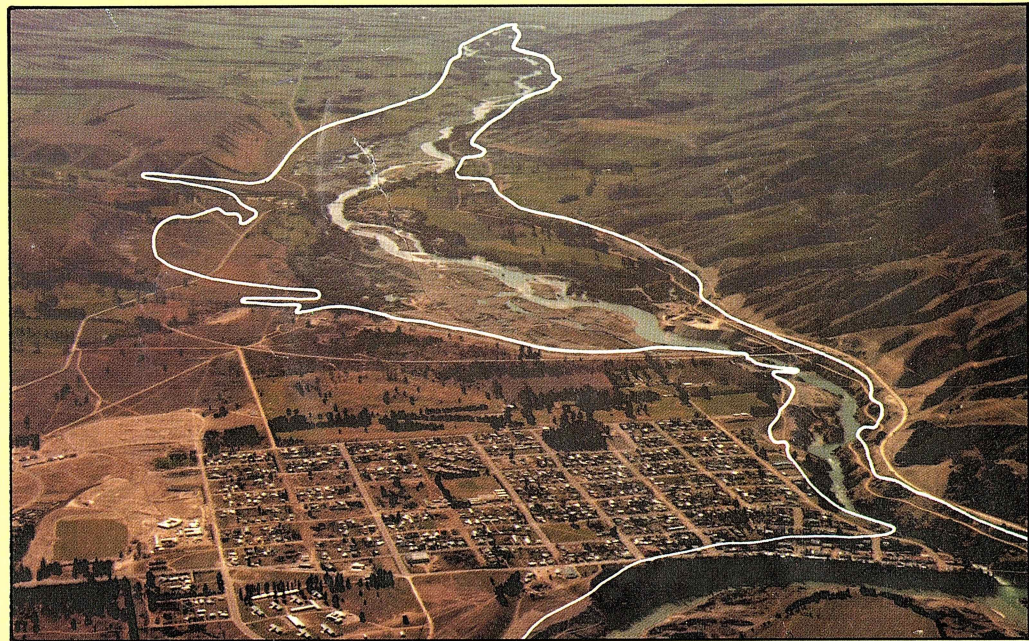
More than 2500 fruit trees were relocated and large quantities of top soil from Lowburn used in new orcharding developments.

At Lowburn a new church and community hall are planned and private developers are planning a new motorcamp and hotel.

Lake Dunstan will bring its own form of compensation to the area with fishing and swimming, boating and picnicking and attractive lake views.

ABOVE: The outline shows Lake Dunstan spread out over the Lowburn Flats. The lake will cover 26.4 square kilometres and should become popular for recreation.

BELOW: The old commercial area of Cromwell will be covered by Lake Dunstan. The buildings shown below the white line have been removed in preparation for lake filling. The river on the left is the Kawarau with the Clutha to the right.



GOLD

Fortune and failure on the Clutha



The gold rush which brought thousands of people to Central Otago began on August 16, 1862. That was the day the *Otago Daily Times* announced that two men, Horatio Hartley and Christopher Reilly, had arrived in Dunedin with 87lb of gold.

After the provincial government had promised a reward of £2000, Hartley and Reilly revealed the gold had been found a couple of kilometres downstream of the junction of the Clutha and Kawarau Rivers.

The Clutha River had started to release its riches

Gold fever spread through the community like wildfire. In Dunedin shopkeepers found themselves without staff. Ships bringing settlers to the Port of Otago were left without crews. They were all off to the Dunstan to make their fortunes.

Within days 2000 men left Dunedin, and when the first gold escort left the goldfields on October 6, 1862, it had on board 6030 ounces of gold.

From September 1, 1862 to April 1, 1863, 120,886 ounces of gold had been recovered from Otago — mainly the Dunstan field. A further 130,000 ounces were taken from the Arrow and Shotover areas.

It seemed the whole province was sown with gold, but by the end of 1864 the most accessible gold had been won and many of the miners were lured away to other fields.

Many of those who remained con-

tinued to make small, but steady incomes. They switched to large-scale recovery techniques like sluicing and crushing the gold from quartz reefs.

The turn of the century saw Central Otago in the middle of another gold boom. Improved dredging machinery saw sensational returns by some dredging companies.

In 1900 there were about 137 dredging companies operating more than 170 dredges in the area.

Fortunes were certainly made — but for many, one month of good returns would be out-weighted by several months of little gold found.

The dredging boom was a short one and most had gone within a few years. Some kept working, and one which deserves special mention is the *Austral Malay* which worked from 1940 to 1952. It was reputed to be the world's largest gold dredge, weighing 3300 tonnes and employing about 40 men.

The gold search continues in the area with some dredges still operating, particularly in the Shotover.

Removing the old commercial area of Cromwell also created the opportunity for a company to work its way through unprocessed gravels.

There is still the opportunity to look for "colour" with a gold pan and the formation of Lake Dunstan is predicted by some to create "drop zones" where streams and rivers will deposit their gold when they meet the lake.

Fascinating history will not be forgotten

Development of the Clutha River will provide hydro electricity for the future, but the past has not been forgotten. In fact, the hydro scheme which will inundate some sites of historic interest has enabled the Upper Clutha Valley to become one of the most thoroughly archaeologically-surveyed areas in New Zealand.

An archaeologist, Dr Neville Ritchie, worked on the Clutha Valley Development for 10 years on secondment from the Historic Places Trust.

His work was to examine all the areas of archaeological interest in the Upper Clutha, particularly those affected by hydro construction.

In those 10 years more than 2000 sites were recorded and 50 areas fully excavated.

The best-known of the archaeology "digs" was in the Cromwell Chinatown. The site had been abandoned by 1920 and completely overgrown. Dr Ritchie and a team of 18 assistants worked for 10 weeks in 1980 on the biggest archaeology excavation carried out in the area.

They gained a wealth of information and recovered many artifacts, some of which are on display in the Cromwell Museum and the Clutha

Valley Development Information Centre in the Cromwell Mall.

Cromwell Chinatown was cleared during lakeshore stabilisation work, but fortunately the lifestyle of the Chinese miners are well recorded in another Chinatown which has been restored in Arrowtown.

Dr Ritchie not only studied and recorded the sites of Chinese miners. His work included researching sites of the European mining invasion of Central Otago; pre-European visitors to the area and natural deposits which pre-date humans. Moa bones, remains of tuatara and extinct birds have helped piece together the early history of the area.

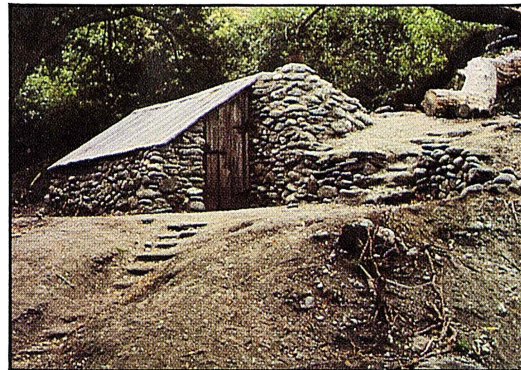
The CVD archaeology programme enabled countless school groups, special interest clubs and university students to see major excavations being carried out and a comprehensive archaeology programme in action.

In all, about 250 sites considered of historic interest will be flooded by Lake Dunstan. Fortunately most are duplicated in some form in other areas of Central Otago.



LEFT: An archaeologist worked on the Clutha Valley Development for 10 years, enabling hundreds of students to take part in "digs" which explored the history of Central Otago.

BELOW: The archaeologist recovered hundreds of artifacts, including these storage jars from Chinatown.



ABOVE: Cromwell's Chinatown was excavated and a hut restored to recreate a fascinating part of the town's history before Lake Dunstan covered the area.



RIGHT: Remains of a gold dredge in the Kawarau River.





AERIAL VIEW CROMWELL MAY 1985

- 1. Deadmans Point Bridge
- 2. Cromwell Mall
- 3. Anderson Park
- 4. New housing area
- 5. CVD Project Office
- 6. Private Industrial Area
- 7. Project Industrial Area

River rules Cromwell's life

The Clutha River has had a powerful influence on the development of the town of Cromwell. The town sprung up almost overnight when gold was found in the area. A little more than 100 years later the town was rapidly expanded because of hydro power.

The 1862 goldrush drew men and some women from far and wide to a point where the Clutha and Kawarau Rivers meet. Known originally as The Junction, it was later to be called Cromwell.

Like many other gold mining towns, Cromwell's growth was spectacular. At one stage Cromwell had nine hotels and supported a population of 10,000 from the surrounding districts.

Cromwell's strategic location, acting as a hub between Alexandra, Queenstown, Wanaka, Haast and the Lindis Pass, ensured it did not suffer the same fate as the majority of old gold mining settlements when the easy-won gold ran out.

Bendigo, Macetown, Logantown and the Nevis settlements disappeared, but Cromwell survived as a service centre for an extensive farming and fruit growing area and a popular holiday centre in the summer.

From the turn of the century to the early 1970s the population of Cromwell was relatively static around 1000 people, with short-term influxes

of holidaymakers at Christmas.

Expansion of the town related to Clutha Valley Development began in 1976.

Decades of development occurred within a few years. In co-operation with the Cromwell Borough Council, the Ministry of Works and Development planned housing and associated facilities to cope with a population which grew to nearly 4000.

More than 400 new houses were built to accommodate the CVD workforce and families. An additional 80 houses were relocated from Twizel and two single worker camps constructed.

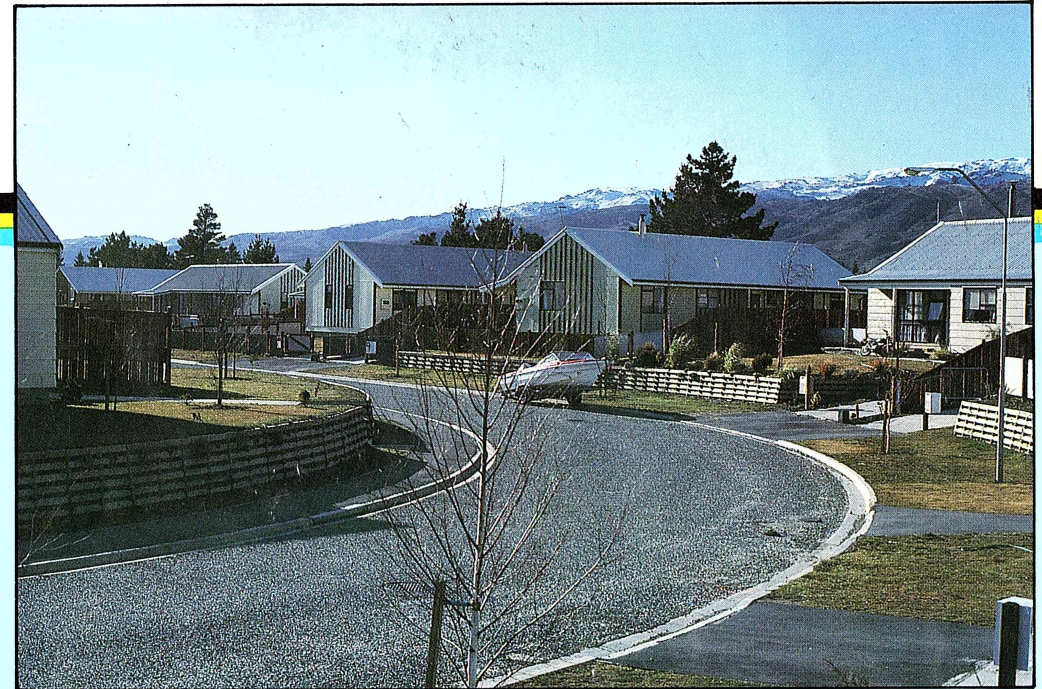
The first housing sub-division was completed in 1977 and received a special commendation from the Otago Division of the New Zealand Institute of Architects.

The new houses are grouped in clusters around small cul-de-sacs with the emphasis on traffic free surroundings.

Most houses have direct access to landscape reserves incorporating cycle and pedestrian greenways and play areas.

A new college and primary school were built, with the other primary school taking over the former college building. The original primary school is being developed as a youth learning centre.

Between the new housing area and established area of Cromwell is



ABOVE: Accommodation for the hydro workforce included these attractive permanent homes, most of which have direct access to attractive greenways.

RIGHT: The Cromwell Mall includes borough council offices, a library and museum.

the Anderson Park sporting complex. In this area is the college with modern auditorium and gymnasium which are available for use by the community, sporting fields, tennis and netball courts and swimming centre.

Adjacent to the centre is the public gardens with rose beds, a fountain and a children's playing area.

Service facilities were also upgraded in the town to cope with the increase in population. These include a new water supply system, sewerage and stormwater services and upgraded streets.



Cromwell – the newest old town in the country



The Cromwell Mall enables Cromwell to lay claim to being “the newest old town in the country”.

The mall was developed as a result of the impact of Lake Dunstan on the old commercial area of the town.

Lake Dunstan will flood the area which used to house virtually the entire commercial area of Cromwell. Located on the lower terrace of the town, the commercial area included several buildings and hotels which dated back nearly a century.

Fortunately the buildings regarded as the best of the stone architecture in the town — the churches — are above the lake line.

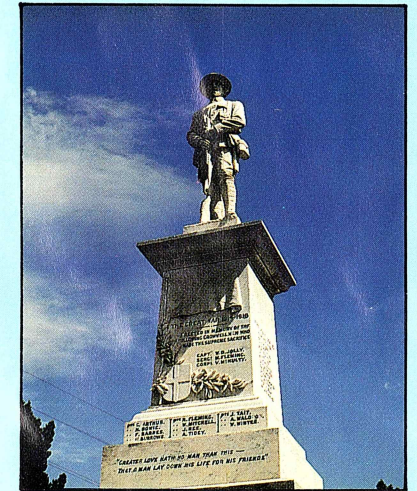
During 1984-85 the old businesses closed and reopened in the new mall. The mall contains shops, offices, banks, borough buildings and an information centre. The mall features a stream, planter beds, seating and a central area which has proved popular for summer entertainment.

Strategically located around the mall is the special commercial area containing petrol stations and bus depots. There is also extensive parking.

Many of the buildings in the mall feature Central Otago schist, particularly the borough buildings (museum, library and council offices).

Near the mall a new hotel with restaurant has been built and an accommodation area developed.

A memorial centre has been developed adjacent to the Memorial Hall. It features the soldiers' monument and 1916 German field gun



ABOVE: The Soldiers' Memorial which used to stand guard over the meeting of the rivers has been relocated to a new Memorial Centre.

LEFT: The Cromwell Mall which was officially opened by the then Minister of Works and Development, Fraser Colman, on Saturday, February 23, 1985.

which have been relocated from their site at the meeting of the rivers.

An historic precinct which includes a number of relocated and restored stone buildings has been developed near the Masonic Lodge and Victoria Arms Hotel (the only original hotel in the town to survive from the gold mining days).



ABOVE: The old commercial area of Cromwell which was demolished in preparation for the filling of Lake Dunstan.



ABOVE: A mining company is working through the area under the old commercial area of Cromwell in search of gold.

Lake Dunstan promises big potential

The Clyde Dam, will create a 26-square kilometre lake which will be called Lake Dunstan.

The lake will extend up the Cromwell Gorge to Cromwell and widen out over the Lowburn Flats.

The lake will offer vast recreational and leisure potential. Areas are being developed for boat launching, beach areas for swimming, and there will be many areas ideally suited for picnics, barbecues and, of course, lake fishing.

Cromwell's central location between Wanaka, Queenstown and Alexandra will enable it to develop as a holiday base, particularly for coastal South Islanders who come to Central Otago in their thousands each summer.

Cromwell is also well located for winter visitors and is only a little over an hour from three ski fields.

The population of the town is expected to drop as the project wind down continues. However, the tourist market and the development of tourism training facilities provide potential for the town.

The developing of large-scale orcharding near the town is also expected to provide a great deal of seasonal and permanent employment.

Cromwell has a wide range of facilities and attractions. Few towns the size of Cromwell can boast so many new facilities, including a heated indoor swimming centre.

Sporting facilities for golfers, bowlers, tennis players, hunters and fishermen are considered first class.

The Cromwell Mall is a popular shopping centre for locals and visitors, and the attractive stream and traffic-free surroundings make it a pleasant place to visit and relax. The museum and information centre attract large numbers of visitors.

Cromwell was founded on gold, expanded because of hydro power, and is now looking to fruit and tourism to maintain its future.

